Control of Flux Pinning in High Temperature Superconducting Tapes

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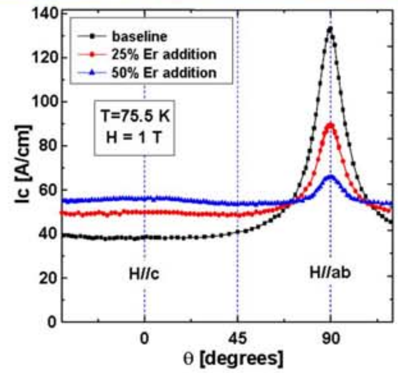
MOTIVATION

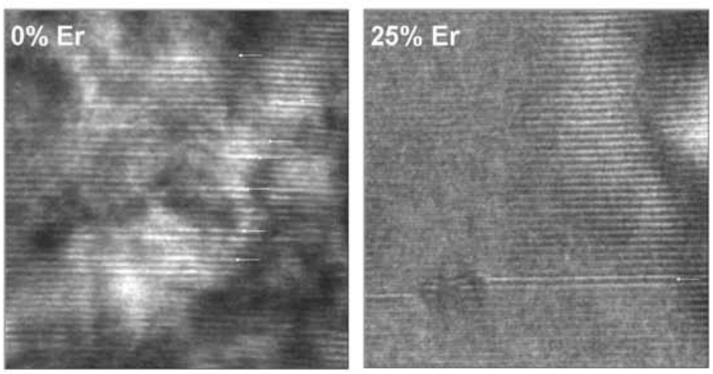
Improving the performance of $YBa_2Cu_3O_x$ (YBCO) superconducting tapes in the presence of magnetic fields is one of the most significant challenges for their application in electric generation and distribution. We have learned how to improve in-field performance through manipulation of composition and processing, but the underlying mechanism that controls this behavior must be understood.



The critical current, Ic, as a function of field orientation can be manipulated through composition and processing.

MAJOR ACCOMPLISHMENTS

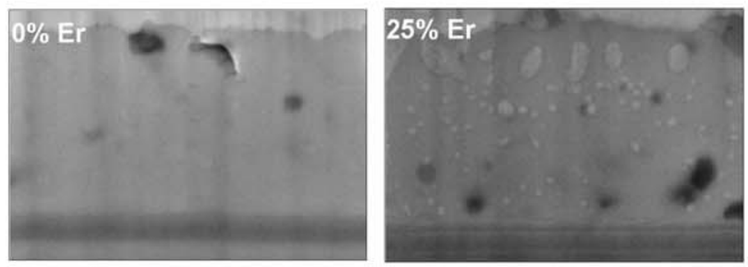
We have elucidated the role of microstructural defects on in-field performance of these superconducting tapes. The variations in critical current as a function of field orientation can be explained based on the interplay between two types of defects.



25 nm

Planar defects dominate for low Er content and provide strong pinning and high I_c for H//ab

TEM

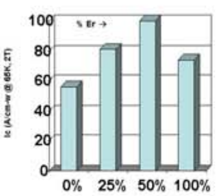


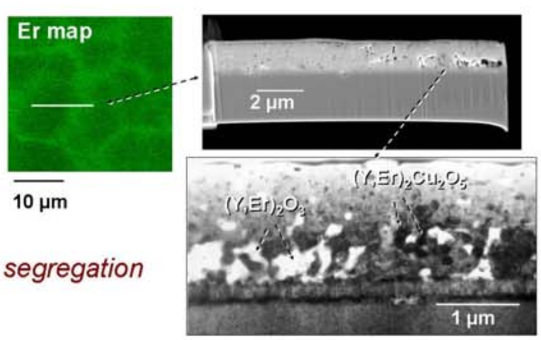
500 nm

$(Y,Er)_2O_3$ particles dominate for higher Er content and provide strong pinning and high I_c for H//c

TEM

Why not add more Er to improve Ic for H//c further??





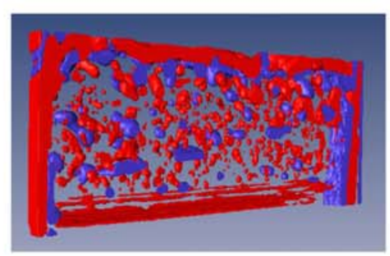
10 μm

Grain boundary segregation

FUTURE DIRECTIONS

Understanding how defects control performance in the superconducting tapes suggests that if we learn how to control those defects, we can manipulate properties more effectively. Can we achieve both planar defects *and* small particles at the same time?

3-D microstructure reconstruction provides an excellent pathway to identify the phase assemblage and quantify distribution.



We will couple analysis of partially converted tapes with thermodynamic phase analysis to identify the key constituents that lead to defect formation. The decrease in planar defect density with increasing Er addition suggests a change in phase assemblage.

"Coordinated Characterization of Coated Conductors," V.A. Maroni, D.J. Miller, S. Trasobares, Y. Lei, J.M. Hiller, K.E. Gray, V.K. Vlasko-Vlasov, H. Claus, J. Reeves, M. Rupich, W. Zhang, T. Kodenkandath, X. Li, IEEE Trans. Supercon. 15 (2): 2798-2802 (Jun. 2005)

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